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Aspects of the biology of Dippers *Cinclus cinclus minor* in the Atlas Mountains of Morocco outside the breeding season

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Abstract. The distribution, diet and biometrics of Dippers were studied in the Atlas Mountains of Morocco in November and December 1986. Existing records from Morocco were also reviewed. Dippers were widespread on permanent rivers throughout the High Atlas, with some stretches supporting four to five birds per kilometre. They occurred too on permanent rivers in widely separated localities in the Middle Atlas. Throughout the Atlas Mountains, Dippers were rare on temporary rivers. Most prey items were aquatic, with Hydropsychidae (Trichoptera) and Baetidae (Ephemeroptera) providing 72 % of the diet, and adult Coleoptera, polycentropodid caddis and *Gammarus* also important. Diet appeared to be related to available prey along at least three rivers, suggesting that Dippers foraged opportunistically in the winter. Biometric data from 12 Dippers mist-netted in the High Atlas indicated that individuals of *Cinclus c. minor* are larger than those of any other race for which data are available. The geographical variation in size is discussed in relation to latitude and altitude.

Key words. Distribution, diet, biometrics, *Cinclus cinclus*, Atlas Mountains.

Introduction

The monogeneric family Cinclidae is Holarctic, Oriental and Neotropical in distribution, being unrepresented in Australasia or in Africa outside the Palearctic region to the north of the High Atlas Mountains. Occurrence on the latter continent is confined to a race of the Eurasian Dipper *Cinclus cinclus minor* Tristram, 1870. However, despite likely genetic isolation from other populations and existence at the southern end of the species' range, there have been no published accounts of the biology of Dippers in North Africa, other than general descriptions of distribution and systematics (e.g. Heim de Balsac & Mayoud 1962, Vaurie 1959). Clearly, the ecology of this riverine passerine is of interest in an area of generally low rainfall where suitable permanent water-courses are few.

In this paper, we provide information on the abundance and distribution of Dippers at several localities in the Middle and High Atlas Mountains during November and December 1986. We describe their diet in relation to available prey, and we provide biometric data from a small sample of live birds.

The Study Area

Studies of distribution, diet and biometrics were undertaken in the High Atlas Mountains east of Asni (31° 17' N, 7° 58' W; c. 2,000—3,000 m O.D.), along the rivers Ourika and Oued Rhirhaia. Samples for dietary assessment were also collected from the Middle Atlas Moun-

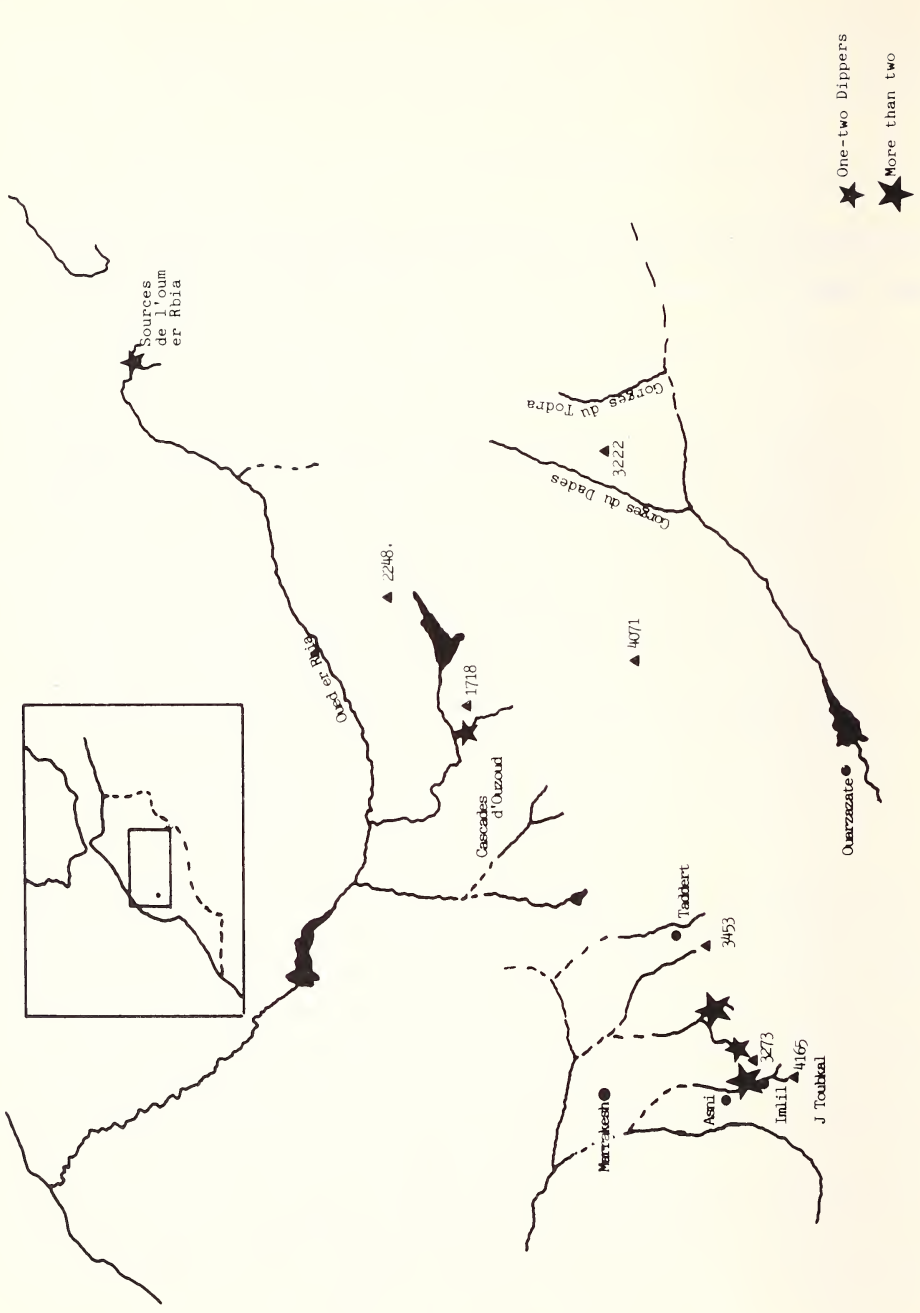

Fig. 1: Sketch map of Morocco showing locations mentioned in text, and sites where Dippers were recorded during this study.

tains at the Sources de l'Oum er Rbia, to the north east of Khenifra (32° 58' N, 5° 46' W) (see Fig. 1). Other rivers where Dippers were seen on casual inspection are given in Table 1.

Watercourses varied from torrential head-streams with rocky riffles, deep pools and waterfalls (e.g. Oikameden 4,000 m O.D., width 1—2 m) to wider (3—25 m), but fast-flowing rivers at 1—2,000 m O.D. Water samples taken for analysis indicated relatively high calcium (15—70 mg l^{-1}) and magnesium (10—23 mg l^{-1}) concentrations, consistent with relatively high invertebrate productivity. Local sources of salinity (e.g. 346 mg Cl l^{-1}; 51 mg SO_4 l^{-1}) were apparent in some areas, probably from mineral springs (e.g. Sources de l'Oum er Rbia). Surrounding vegetation on the dry rocky hills included a sparse scrub cover of *Cupressus*, *Lentiscus* and other xeorophytic shrubs, although some valley floors were more fertile, with extensive irrigation schemes. In these cases, such as the Ourika and the Oued Rhirhaia from Asni up towards Imlil, wet grassland, crops and orchards lie adjacent to the river; patches of bramble, scrub, scattered Willows *Salix* sp., Poplars *Populus* sp. and Walnuts *Juglans regia* often form a bankside lining, whilst a rich marginal vegetation of *Apium*, *Rorrippa*, *Mentha* and other plants may grow alongside slow-moving stretches. In all cases, rocks, shallow riffles and pools provide suitable feeding areas for Dippers, whilst many low cliffs provide nest-sites. Other typical species of birds on these rivers include Grey Wagtails *Motacilla cinerea* and Green Sandpipers *Tringa ochropus*, with Cetti's Warblers *Cettia cettia* and Wrens *Troglodytes troglodytes* in cover at the edges.

Methods

Distribution and habitat characteristics

Spot checks were made at both permanent and seasonal water-courses in the Jebel Toubkal area of the High Atlas and at a number of sites in the Middle Atlas (Fig. 1, Table 1). Stretches of 100—200 m were surveyed for Dippers or for signs of their presence (e.g. faeces or regurgitated pellets on rocks). On two rivers (Ourika and Oued Rhirhaia) censuses were carried out over lenghts of up to 4 km, and descriptions of stream physiography and bankside vegetation were made on site.

Diet and available prey

Diet was assessed at nine sites by the analysis of five to ten fresh faecal pellets, in two cases supplemented by the examination of regurgitates. Samples were preserved in 70 % alcohol and subsequently analysed using methods described by Ormerod (1985) and Ormerod & Tyler (1986). Aquatic invertebrates were identified to family and quantified by counting mouthparts or other key structures at magnifications of x 12 to x 40. Dry weights were reconstructed from known relationships with mouthpart size (see Ormerod & Tyler 1986).

Wherever faecal samples were collected, the relative abundances of available prey were assessed by kick-samples of approximately 30 s duration, the substratum of shallow riffles being transferred into a hand net. Samples were tipped immediately into white sorting trays, and the number of individuals from each major family were counted. Whilst this method is likely to underestimate the abundances of small invertebrates (e.g. Chironomidae, Elminthidae), such items were not important components of the diet of Dippers in this study or elsewhere (Ormerod 1985, Ormerod & Tyler 1986, Ormerod et al. 1987).

Biometrics

Where possible, Dippers, once located, were driven into mist nests set across the water-course. Weights were recorded to ± 0.2 g using a Pesola balance, wing lengths to ± 0.5 mm (maximum chord) using a topped ruler, and tarsal length (after Schmid & Spitznagel 1985), bill depth and bill length (from feather) to ± 0.01 mm using vernier calipers. Each bird was aged and sexed using criteria suggested elsewhere (Svensson 1986, Ormerod et al. 1986), although sex determination was re-appraised according to the biometrics of the study population (see below).

Results

Distribution

In the High Atlas, Dippers were located on the Oued Rhirhaia, Ourika and Oikameden rivers, all of which are permanent water-courses. Birds were apparently absent from temporary rivers at lower altitudes (Table 1). In the Middle Atlas, Dippers were seen only at the Sources de l'Oum er Rbia and below the Cascades d'Ouzoud (Fig. 1).

Most birds were seen on a 2,5 km stretch of the Oued Rhirhaia below Imlil, with a minimum of 11 Dippers recorded. Spot checks elsewhere along this river indicated a similar abundance of four to five birds per kilometre, although only one bird was recorded in 1 km above Imlil. Consequently, overall abundances on this river were 2.125 per km. On the Ourika, there was a minimum of eight birds in 4 km below Setti Fatama. Observations of Dippers at other sites suggested that the birds were not uncommon where they occurred (Table 1).

Diet

Apart from single specimens of adult Diptera and larval Lepidoptera, all the dietary items (n = 1209) were aquatic. At all but two sites, the trichopteran family Hydropsychidae formed the single most important prey, providing 22—80 % of the items recorded (52.1 % overall and 88 % by weight) (Table 2). The ephemeropteran family Baetidae was the second most important group at most localities and, for all sites combined, provided 22 % of the diet. These two groups were amongst the commonest invertebrates present in riffles at the sites and, overall, there were significant correlations between the percentage composition of the diet and available prey along three rivers (Fig. 2).

Other notable inclusions in the diet were adult Coleoptera, polycentropopodid caddis at the high altitude site (Oikameden), *Gammarus* sp. taken from a saline spring at the Sources de l'Oum er Rbia, and *Hydra* sp. (occurring only in regurgitates).

Table 1: Distribution and abundances of Dippers on rivers in the Middle and High Atlas of Morocco during November/December 1986 (locations in Fig. 1)

River	Length surveyed (km)	No. birds seen
Oued Rhirhaia/Mizane R. from 3—7 km below Imlil	4	11
to 1 km above Imlil	1	1
Ourika River from 4—8 km below Setti Fatama	4	8
Oikameden R.	1	1
Sources de l'Oum er Rbia	1	2
Cascades d'Ouzoud	0.5	1
Moulay Brahim below Asni	3	0
Oued N'Fis	Frequent checks	0
Oued Reghaya	"	0
South of Azrou	"	0

Table 2: The diet of Dippers at nine sites in the Atlas Mountains of Morocco during November 1986. The values for each invertebrate taxon are percentage contributions by number and by weight.

Taxon	Mean weight (mg)	By number (%)	By weight (%)
Hydrazoa (Hydra)		2.3	< 0.1
Oligochaeta		< 0.1	< 0.1
Mollusca		< 0.1	< 0.1
Crustacea			
Gammaridae	5.5	0.8	0.5
Insecta			
Ephemeroptera			
Baetidae	0.63	22.4	1.7
Plecoptera			
Leuctridae/Nemouridae	2.2	3.5	0.9
Perlodidae	8.35	4.4	4.5
Coleoptera	2.5	4.0	1.2
Trichoptera			
Rhyacophilidae	4.62	0.6	0.3
Polycentropodidae	1.18	4.0	1.2
Hydropsychidae	13.67	52.1	88.5
Limnephilidae	47.0	0.2	1.2
Diptera			
Simuliidae	0.56	5.2	0.3
Adult Diptera	N/A	<0.1	< 0.1
Lepidoptera	N/A	< 0.1	< 0.1
Heteroptera			
Corixidae	N/A	< 0.1	< 0.1
Total items		1209	9731

Table 3: Biometrics of Dippers in the Middle and High Atlas Mountains of Morrocco during November 1986. The sample size was insufficient to allow standard deviations for females.

	Males (n = 9)	Females (n = 3)
	$\bar{x}$ (S.D.)	$\bar{x}$
Wing length (mm)	102.8 (1.9)	94.3
Weight (g)	76.0 (3.6)	68.1
Tarsus (mm)	36.1 (0.8)	34.9
Bill length (mm)	13.7 (0.7)	12.9
Bill depth (mm)	4.9 (0.3)	4.6

Biometrics

In other races of Dippers, the sexes are separable from their biometrics, particularly wing length, although the division is geographically variable (e.g. Anderson & Wester 1971: males > 94 mm; Rockenbauch 1985: males > 91 mm; Ormerod, Tyler & Lewis 1986: males > 93 mm). Our sample of *C. c. minor*, although small, indicated a likely separation above and below 97 mm (one bird with a wing length of 97 mm was sexed as a female on the basis of a short tarsus). With this division, nine males had a mean wing length of 102.9 mm (range 100—106), whilst three females had a mean of 94.3 mm (range 91.5—97.0) (Table 3). Biometric differences were also apparent in weight, tarsal length and bill dimensions (Table 3).

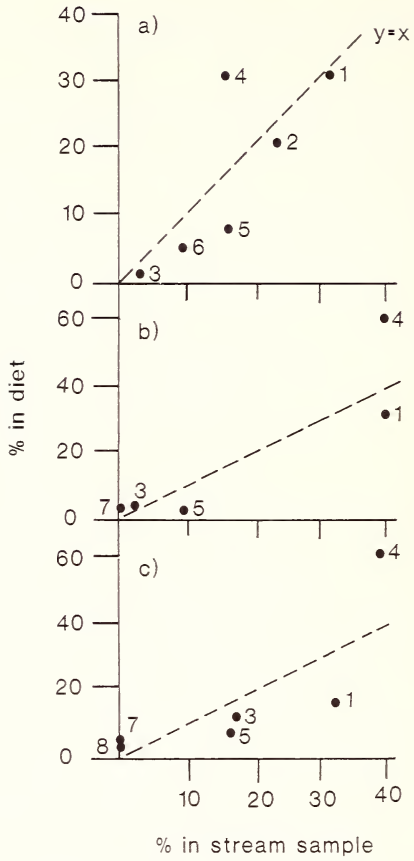

Fig. 2: The diet of Dippers along three rivers in the Atlas Mountains of Morocco in relation to available prey. The values are percentage distributions for Baetidae (1), Leuctridae/Nemouridae (2), Perlodidae (3), Hydropsychidae (4), Simuliidae (5), *Gammarus* (6), Rhyacophilidae (7), Coleoptera (8). Rivers: a) Sources de l'Oum er Rbia ($r = 0.927$, $n = 9$), b) Asni-Imlil ($r = 0.92$, $n = 7$), c) Ourika ($r = 1.00$, $n = 7$).

Using regressions of weight on wing length (Ormerod, Tyler & Lewis 1986) males were on average 2.1 g heavier than would be expected from their wings, whilst females were 3.4 g heavier. These values would be expected in Dippers during the winter period when birds are gaining weight prior to breeding. However, care should be taken in interpreting these data because they are based on a regression relationship derived from a different race and a small sample.

Discussion

Distribution

Previous indications are that Dippers are scarce in Morocco, occurring mostly in the High Atlas and Rif; there are few, mostly recent, records from the Middle Atlas

Table 4: Previous records of Dippers in Morocco.

Reference	Records
Lynes (1920)	Absent from the Middle Atlas
Hartert & Jourdain (1923)	Local in the High Atlas (as in Algeria): Quoted H. Voucher as seeing a Dipper in 1902 in mountains near Tetuan; Meade-Woldo — a number on Oued Assniz, east of Tizi Gourza; one collected by Riggenbach near Tamarouthe.
Chaworth-Musters (1939):	Fairly common along mountain streams of Jebel bou Ourial; a few pairs in winter along stream near Taddert, moved to higher ground in March/April.
Meinertzhagen (1940)	Single bird at Taddert on 16 October. Noted Dippers had been frequently reported from High Atlas but absent Middle Atlas.
Bannerman & Bannerman (1952) Bannerman & Priestley (1953)	Searched on river near Taddert and on Oued n'Fis but saw none.
Heim de Balsac & Mayoud (1965)	Widely distributed in High Atlas from Azilal in east to l'Oued Amzinis in west, but absent from Middle Atlas. Found commonly on some water-courses such as l'Iminene up to Col de Tizi n Tacchedirt (3600 m) but absent from Oikameden stream.
Etchecopar & Hue (1967)	Breeds in Rif and High Atlas.
Louette (1973)	No observations in Middle Atlas, but present in Rif and High Atlas. Three collected near Ifrane.
Smith (1965)	Normally sedentary at high altitudes; one at 9000 ft. in Jebel bou Ourial in Feb.; one at Ouamana at foot of Middle Atlas, south-west of Khenifra in Nov.
Stuart Housden (pers. comm.)	Two building nest at Sources de l'Oum er Rbia 8 May 1979.
Rae Vernon (pers. comm.)	Breeds in small area of Rif, more wide-spread in High Atlas and known from the Middle Atlas since mid 1970s.
Sheila MacDonald & Chris Mason (pers. comm.)	One north-east Khenifra in 1982.

(Table 4). Our data support these observations, the pattern presumably reflecting the relative availability of permanent streams. Whilst Dippers may use seasonal rivers in the autumn and winter during altitudinal migration (Etchecopar & Hue 1962), or natal dispersal, our limited surveys revealed a marked scarcity along them. Possibly, the limited macroinvertebrate fauna of temporary streams makes them less suitable: hydropsychid caddis larvae (the commonest prey) were only abundant in permanent streams, and probably exert some influence over Dipper abundance (Ormerod et al. 1985). The high abundances that we recorded on the Oued Rhirhaia and Ourika river could have resulted from temporary winter movements from higher altitudes, although their macroinvertebrate faunas could probably support dense breeding populations. Surveys on these rivers during the breeding season would be of interest.

It is interesting too to speculate whether the Middle and High Atlas Mountains, with a more complete soil and forest cover and more extensive network of permanent streams, may once have held a much larger Dipper population.

Diet

In previous studies of the diet of Dippers during winter, Jost (1975) and Spitznagel (1985) recorded *Gammarus* as the most frequent prey in central and southern Germany, whilst larval Simuliidae were most frequent in Wales (Ormerod & Tyler 1986).

However, Ormerod & Tyler (1986) showed that the diet of Dippers in winter was spatially variable, strongly reflecting available prey; they concluded that Dippers at this time foraged opportunistically, in contrast to the breeding season (Ormerod 1985). Our data from the Atlas Mountains also indicated opportunistic foraging, with diet related to available prey along at least three rivers. However, at all sites, hydropsychid larvae were taken in greater proportions than was expected from their contribution to the benthic fauna. Such selection by Dippers probably reflected larval weight, relative immobility, lack of sclerotisation and their accessibility in the substratum.

Biometrics

Our data indicate that individuals of *C. c. minor* are larger than those of any other race of Dippers for which data are available from live birds. Males had significantly longer wings than *C. c. aquaticus* in southern Germany (94.70 mm ± 1.93 S.D; $t = 10.99$, $p < 0.001$; Schmid & Spitznagel 1985), *C. c. gularis* in Wales (96.70 ± 1.97, $t = 4.97$, $p < 0.001$; Ormerod, Tyler & Lewis 1986), and *C. c. cinclus* in Sweden (98.41 ± 1.78, $t = 4.11$, $p < 0.001$; Anderson & Wester 1971). Whilst we had insufficient data to make statistical comparisons for females, it seems likely that similar differences are apparent: body size in male and female Dippers is closely correlated across populations, including *C. c. minor* (Fig. 3). Cramp (1988) notes that *C. c. persicus* from south-west Iran is larger than *C. c. minor*: mean wing length of males 100.5 mm (range 98–104); females 92.1 (90–94), but inferred this from only nine skins. Skins of four males of *C. c. minor* from Morocco gave a mean wing length of 99 mm (97–102), shrinkage probably explaining the difference from live values (Table 5).

Table 5: Measurements of skins of male Dippers at the Museum, Tring. A correction factor was calculated by comparing skins and live birds of three races. A specimen labelled as a female but with wing length of 101 mm was presumed to be a male *C. c. minor*; see last line of table.

Race	Mean wing length	S.D.	Number	+	Corr. f.
Cinclus c. aquaticus	94.7	+ 1.99	12		98.49
C. c. gularis	93.45	+ 2.04	12		96.70
C. c. minor	99	+ 2.12	4		102.77
C. c. minor	99.4	+ 2.04	5		

Comparisons of body weight are difficult due to seasonal variation. However, the mean values recorded here (males 76.0 g, females 68.3 g) are larger than those of wintering Dippers in Wales (67.3 g, 57.85 g Ormerod, Tyler & Lewis 1986) or Scandinavia (67.8 g, 57.8 g Anderson & Wester 1971) in accordance with the general biometric pattern. In Europe, the geographical variation in the body size of Dippers has been explained by Bergmann's rule (Bergmann 1847), birds being larger in the cooler north (Fig. 3). However, *C. c. minor* in Morocco does not conform to this latitudinal pattern, possibly because of low temperatures at the high altitudes at

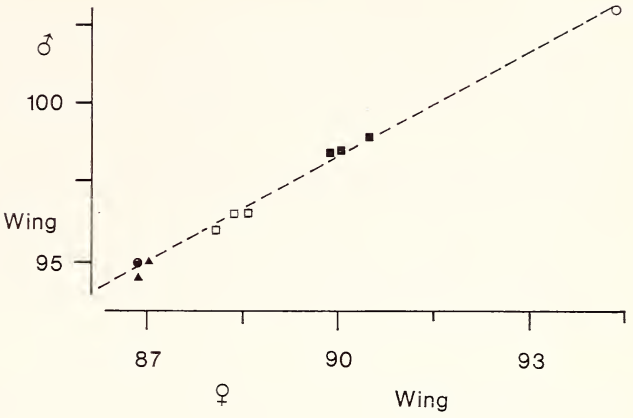

Fig. 3a: Male v. female wing length for Dippers in different localities:
○ *C. c. minor*,
■ *C. c. cinclus*,
□ *C. c. gularis*,
▲ *C. c. aquaticus*,
● *C. c. hibernicus*
(Perry 1987; other sources in text).

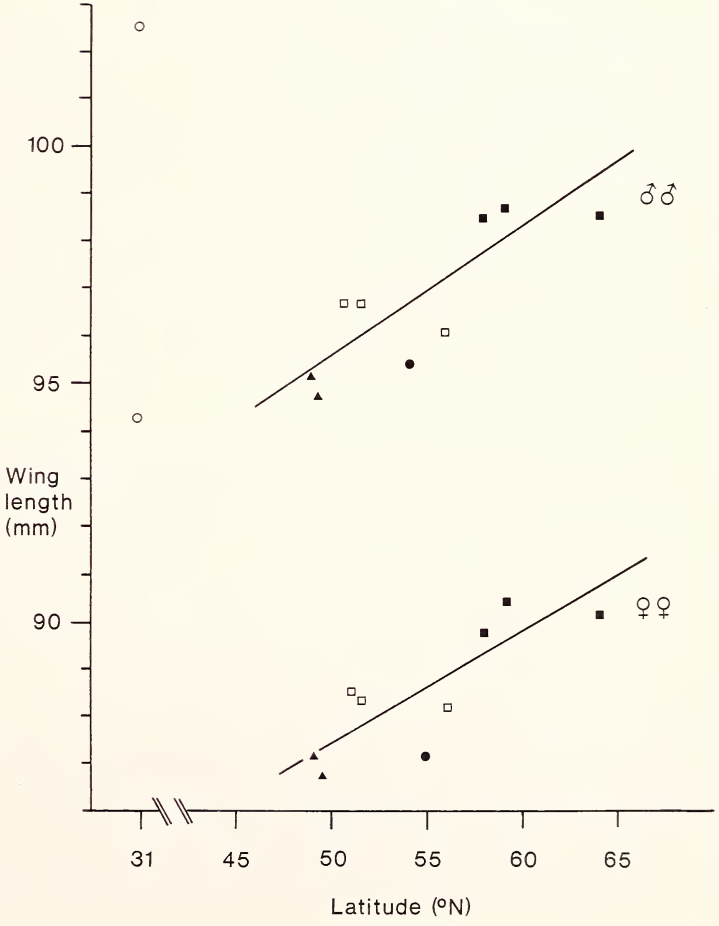

Fig. 3b: Wing length for male (upper) and female (lower) Dippers in relation to latitude for Dipper populations. The regression lines (fitted by least squares) exclude *C. c. minor*. Conventions as in Fig. 3a.

which Dippers occur there (see James 1970). Clearly, further biometric data from Dippers in other areas of Morocco (e.g. Rif mountains) and from high altitude areas of Europe would prove interesting. Additionally, relationships between body size and temperature would be instructive, although such meteorological data are not readily available.

Tristram (1870) suggested the subspecific name *minor* for North African Dippers on the basis of one small female from Algeria, where Payn (1948) also described a small female Dipper. It would be interesting to examine live birds in Algeria to ascertain whether Dippers are generally smaller there than in Morocco. On our evidence it would seem that Moroccan birds are inappropriately called *minor*.

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Zusammenfassung

Verbreitung, Nahrung und Biometrie der Wasseramsel wurden im marokkanischen Atlasgebirge im November und Dezember 1986 untersucht. Die bisher vorliegenden Nachweise aus Marokko wurden ebenfalls ausgewertet. Wasseramseln waren an perennierenden Flüssen im gesamten Hohen Atlas weit verbreitet, an einigen Strecken mit vier bis fünf Vögeln je Kilometer. An perennierenden Flüssen des Mittleren Atlas kamen sie an weit voneinander entfernten Stellen vor. An temporären Flüssen des gesamten Atlasgebirges waren Wasseramseln selten. Die meisten Beutetiere waren aquatisch, wobei Hydropsychidae (Trichoptera) und Baetidae (Ephemeroptera) 72 % der Nahrung ausmachten; außerdem wichtig waren adulte Käfer, Köcherfliegen der Familie Polycentropidae und Bachflohkrebse (*Gammarus*). Die Nahrung schien an wenigstens drei Flüssen dem Nahrungsangebot zu entsprechen, was eine opportunistische Nahrungssuche der Wasseramseln im Winter nahelegt. Biometrische Angaben von zwölf im Hohen Atlas mit dem Japannetz gefangenen Wasseramseln deuten darauf hin, daß Individuen von *Cinclus c. minor* größer als alle anderen untersuchten Unterarten sind. Die geographische Variation der Größe wird in ihrer Beziehung zur geographischen Breite und Länge diskutiert.

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